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spherical nucleus of *b'* fuses with the nucleus of the egg cell of the archegonium.

While it is hardly safe to generalize from such limited observations (for so far they have been confirmed only on Juniperus and that but partially) nevertheless the observations accord much better with what we should expect from analogy with lower and higher plants. If these observations are confirmed by more extended study the pollen tube must be looked upon as the prothallium, while the small cells constitute the antheridium. The one which travels to the apex of the tube must be the mother cell of an antherozoid, to which the spherical nucleus would correspond. Perhaps on account of the imperfect division of *b'* it would have to be considered as more primitive still, being the homologue of the cells from which the antherozoid mother-cells arise.—R.

BRIEFER ARTICLES.

Notes on pollination.— I. The sandy hills, old trees and fences on the north shore of Long Island are covered with *Ampelopsis quinquefolia* Michx. The numerous small, greenish-yellow flowers are quite conspicuous in contrast with their background of green leaves. On the morning of July 22d, there were twenty-two flowers open on one cyme, the pollen-covered stamens outspread, the erect stigma occupying the flower center. Numerous visitors — honey bees, humble-bees, hornets, Sphecidæ, other Hymenoptera small and large, and Diptera — were either sucking the nectar which is exposed in the base of the flower and accessible to the shortest tongues, or collecting or eating the pollen. Almost all of them touched both stamens and stigma before leaving a flower. Early in the afternoon of the same day stamens and petals had fallen from all of these flowers but the visitors continued their visits as industriously as ever — of course, now only sucking nectar.

On the morning of July 23d, no more flowers had opened, and there were none with stamens on this whole plant or on any of the plants near by. The number of visitors was diminished. Early in the afternoon many new flowers had opened on all the plants and insects abounded. July 24th, at 8 A. M., after a heavy rain, very few stamens and petals remained. At 11 A. M. there were many newly opened flowers. July 25th, at 2 P. M., no stamens.

The stigmas appear to remain receptive for some days and the older flowers which contain them alone are visited as often as the freshly opened ones. Self-pollination, which would be easily accomplished, is only possible in the few hours during which the stamens last and even then, owing to the great number of visitors, cross-pollination seems much more probable in pleasant weather.

II. The species of *Trillium* have, so far as I know, been studied with reference to their pollination only by Loew, whose meager notes on imported plants are recorded in Pringsheim's Jahrbücher, vol. XXIII, p. 238.

Four species are grown in the Botanical Garden at South Hadley, Mass., as nearly as possible under natural conditions.

1. The very inconspicuous, dull reddish-brown flowers of *T. sessile* L. are erect "in the bosom of the leaves." The stamens closely surround the stigma. Self-pollination seems inevitable. There is no honey. No visitors were seen though the flowers were watched at intervals each day during their period of flowering. Loew reports one pollen-eating beetle.

2. *Trillium erectum* L. The rather large, brown-red flowers are abundant and rather conspicuous in the Massachusetts woods in early spring. Their strong, disagreeable odor may perhaps attract carrion-loving flies or beetles. Unfortunately I could not watch the flowers in the woods and there were only a few in the garden. Stigmas and anthers stand at nearly the same level, freely exposed in the flower-center by the recurving of sepals and petals. There is no honey and for many days no visitors appeared. Finally four Coleoptera came in one day, apparently to eat the stamens—certainly of little avail in cross-pollination and probably too late to be of use in any case. Spontaneous self-pollination seems to be the rule here too.

3. One morning, some time after the blossoms had all disappeared, a humble-bee flying by me vanished under the leaves of the blood-root bed and continued his buzzing there so contentedly that it was evident treasure had been found. Following him, and pushing aside the large leaves of the blood-root, I found, concealed under these leaves and their own too, the nodding flowers of *Trillium cernuum* L., well hidden from human view but recognized from afar by the keen senses of their lover. He was busily at work sucking nectar which was afterwards seen in small drops at the ovary base, between the ovary and the bases of the filaments opposite the inner perianth leaves. This species is slightly proterandrous, the stamens dehiscing before the petals are outspread and while the stigmas are still close together. After the nodding flower has fully opened self-pollination is easy, the recurving stigmas being just below the pollen-covered anthers.

4. *T. grandiflorum* Salisb. In the first stage, the mouth of the flower is closed by the anthers. Later, the petals expand further, the stamens separate above and the stigmas appear between them, in the flower-center. A little nectar secreted by the "septal glands" lies between the ovary and filaments as in the preceding species. Hive bees occasionally collect the pollen. The stigmas recurving to meet the stamens may be self-pollinated in the absence of visitors.

III. *Oakesia sessilifolia* Wats., *Uvularia perfoliata* L., *Clintonia borealis* Raf., are visited abundantly by humble bees for the nectar contained in the hollowed bases of the perianth-leaves.

IV. While watching the pollination of Asters and Solidagos this fall, I was surprised to find large numbers of humble-bees, honey-bees, wasps, and other large and small Hymenoptera, flies — notably Syrphidæ, beetles and four species of Lepidoptera, visiting *Solidago squarrosa* whose flowers were all withered, to suck the nectar secreted by the involucral bracts. This is another of the cases of the occurrence of the extra floral nectar whose use, if any, to this plant has yet to be discovered.

An article in the *Biologisches Centralblatt* (vol. VIII, p. 577) may shed some light on the use of these extra-floral nectaries. It is in substance this:

Von Wettstein has observed the accumulation of nectar on the involucral scales of *Jurinea mollis*, *Serratula lycopifolia*, *S. centauroides*, *Centaurea alpina*, &c.

In *Jurinea* the secretion begins when the head has attained one-fourth of its full development: it ceases when the first flowers unfold. It begins each day directly after sunrise, increases until about 8 o'clock and then commonly diminishes until evening. Even before sun rise one may find ants sitting motionless upon the buds; as soon as the nectar-secretion begins they seek most eagerly for the places on the scales at which it appears. Of 250 unopened heads, only ten were without ants. The greatest number on one head was twelve, the average three or four. Not seldom they creep over the flowers so that the purpose seems not to be to exclude them from these. Experiment establishes the truth of the theory that the ants, here as in so many other cases, are the protectors of the plants — the pigmies, the body-guard of the giants, as it were.

Fifty buds were protected against ants by winding their stems with wool soaked in camphor-solution and oil. Fifty others were left untouched. After four days all of the heads were examined. Forty-seven of the last lot remained; forty-five of them (90 per cent.) had blossomed normally; beetles had eaten the involucral scales of two;

one had been broken by the wind. Forty-six of the protected heads remained. Twenty-seven (only 54 per cent.) had blossomed normally; seventeen were more or less injured by animals. Ants had gained access to two.

Experiments with *Serratula lycopifolia* Vill., gave similar results, so that the usefulness of the ants in both of these cases can hardly be disputed. But both plants are natives of the tropics where ants are most abundant and most wonderfully developed.

There were few ants upon the involucres of *Solidago squarrosa.* Perhaps this very fact accounts for the large number of beetles. But the beetles as well as the numerous other visitors all seemed to suck the nectar without doing injury to the head, and moreover they were observed after all or very nearly all of the flowers were gone, and their visits continued until the coming of cold weather, that is for about two weeks, if my memory is good.

Ludwig says: "In Jurinea the involucral scales are reflexed during anthesis forming a protection to the flowers, while the scales of Serratula are appressed and accordingly, in Serratula the secretion of nectar continues after blossoming." Solidago differs from both, for its involucral scales are reflexed, and the secretion is of long continuance· The plants were grown under unnatural conditions, on an exposed hill at the edge of the Horticultural Garden here at Ithaca. It will be necessary to observe them in their own haunts another year to ascertain surely whether ants are their guests and the champions against their foes.—ALICE CARTER, *Ithaca, N. Y.*

EDITORIAL.

A NEW FEATURE for American expositions has been inaugurated by the World's Fair commissioners. It is proposed to hold a series of congresses in connection with the Fair, to which those interested in the various departments of knowledge are to be invited. These are to be conducted in the same generous spirit which characterizes the other projects of the exposition. The preliminary circulars have been issued, and some of the special congresses are already quite well organized.

Plans for the Botanical Congress are now under consideration. What these plans shall be depends largely upon the botanists of the country. It is much to be desired that a full and hearty expression of opinion be made public through the botanical and other journals, to